GOES-R AWG Collocation Project Status

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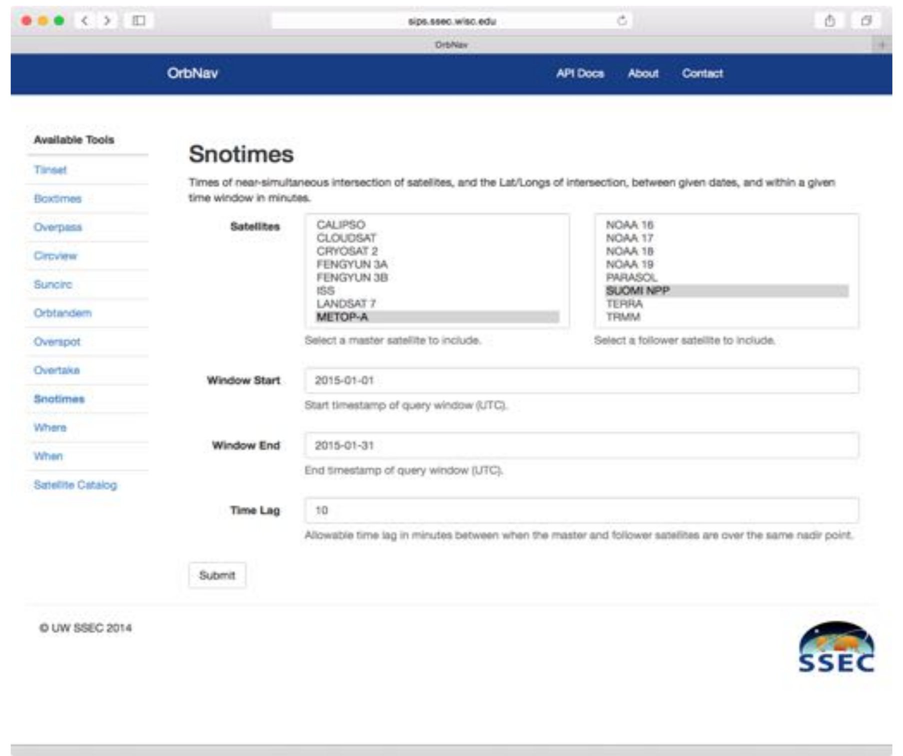
Background and Goals

The GOES-R collocation project aims to support validation of Algorithm Working Group (AWG) products by providing software tools to conveniently bring together datasets from different sensors for comparison. Many of the underlying tools and techniques originated in the 1970s as part of the NOAA group lead by Bill Smith Sr. and Fred Nagle to support early polar and geostationary instruments. The GOES-R AWG project has provided support to greatly expand these tools. Use of efficient algorithms is a high priority, enabling months or years of data to quickly be collocated and compared for statistical analysis or long term monitoring. As part of the GOES-R AWG effort, the collocation project supports the following goals:

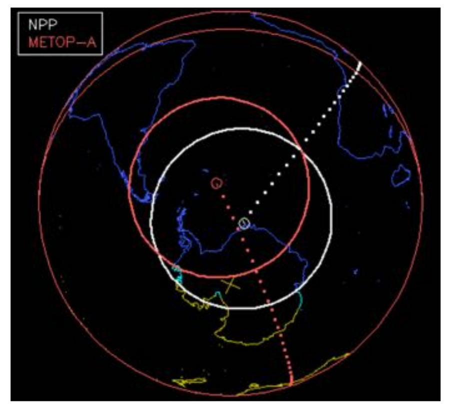
- Develop an extensible and maintainable toolkit (the "collopak" software distribution) capable of orbital analysis (satellite-to-satellite or satellite-to-ground overpass calculations) and pixel-to-pixel collocation for both GEO and LEO instruments.
- Support the collocation needs of GOES-R AWG teams as they work to validate their algorithms. The collocation toolkit will become part of a standard validation framework being developed by the Algorithm Integration Team (AIT).
- Leverage the collocation tools to build an inter-calibration system to allow near real-time monitoring of instrument performance and long-term analysis of radiometric trends.

Orbital Navigation

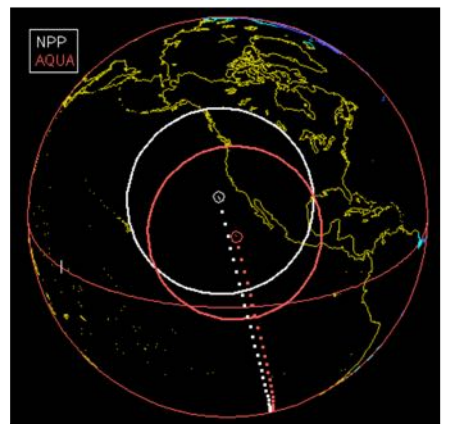
Before pixel-level collocation can take place, pairs of spatially overlapping data files must be brought together. This often involves calculating orbital events involving one or more satellite platforms.



Tools for computing SNOs, tandem events, ground overpasses, and more can be accessed via the web (http://sips.ssec.wisc.edu/orbnav) or used from scripts via an API (http://sips.ssec.wisc.edu/orbnav/api/v1).



Simultaneous nadir overpasses (SNOs) yield short-lived comparison opportunities between LEO sensors.



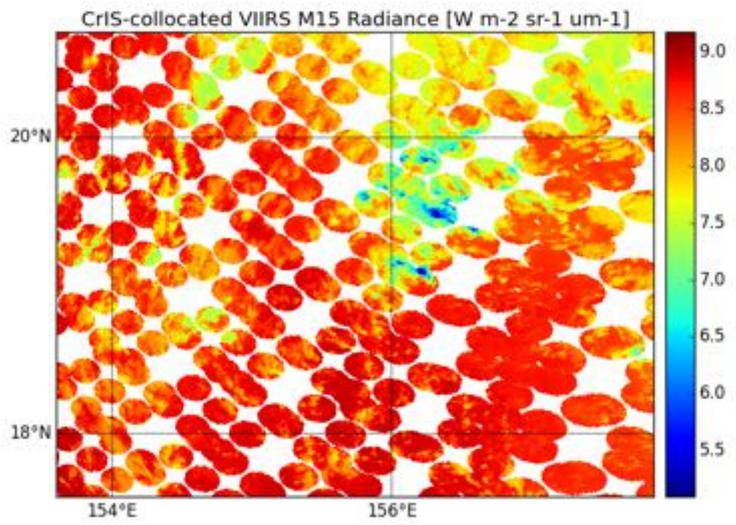
Sun-synchronous LEO platforms with similar local equator crossing times periodically view the same ground locations for several hours ("tandem" events).

Physical Collocation

The physical collocation tools aim to quickly and accurately associate observations from multiple sensors at the pixel level. Modeling spacecraft position and sensor scan geometry enables execution orders of magnitude faster than common brute force methods. Characterizing sensor field-of-view shape and in some cases spatial response behavior provides high fidelity comparisons.

Master \ Follower	AHI	AVHRR	CALIOP	CLOUDSAT	GOES	MODIS	MTSAT	POLDER	SEVIRI	VIIRS
AHI			✸			✸				✸
AIRS			✸	✸	✸	✸	✸		✸	
AMSR-E				✸		✸				
CLOUDSAT			✸			✸				✸
CrIS	✸		✸				✸		✸	✸
COMS			✸			✸				
GOES			✸			✸				
HIRS		✸	✸							
IASI	✸	✸				✸	✸		✸	
MODIS			✸					✸		✸
MTSAT			✸			✸				
SEVIRI			✸			✸				✸
VIIRS			✸							

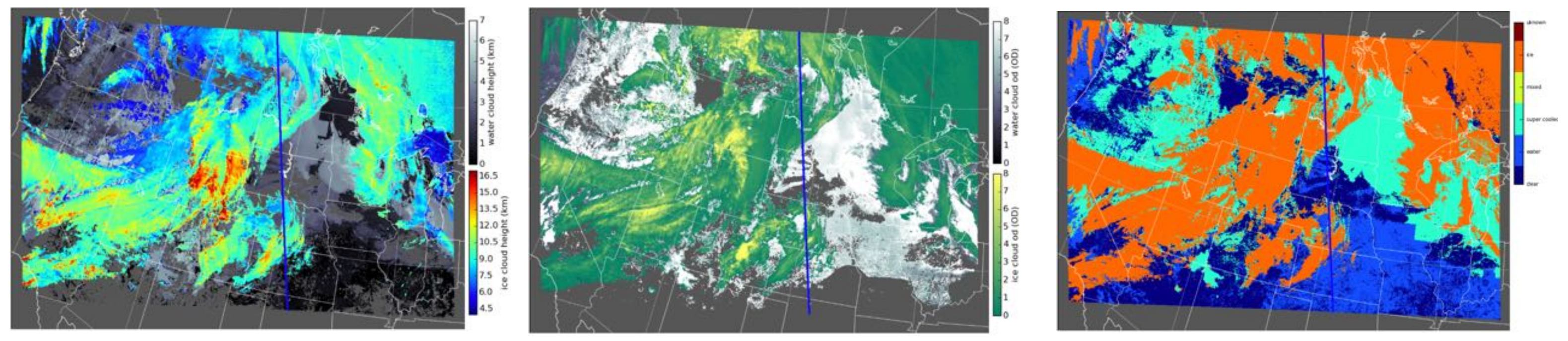
Sensor pairs supported for collocation are shown to the left. The "master" in each pair has the larger spatial footprint. The physical collocation tools will find the set of "follower" observations that reside spatially within each master footprint.



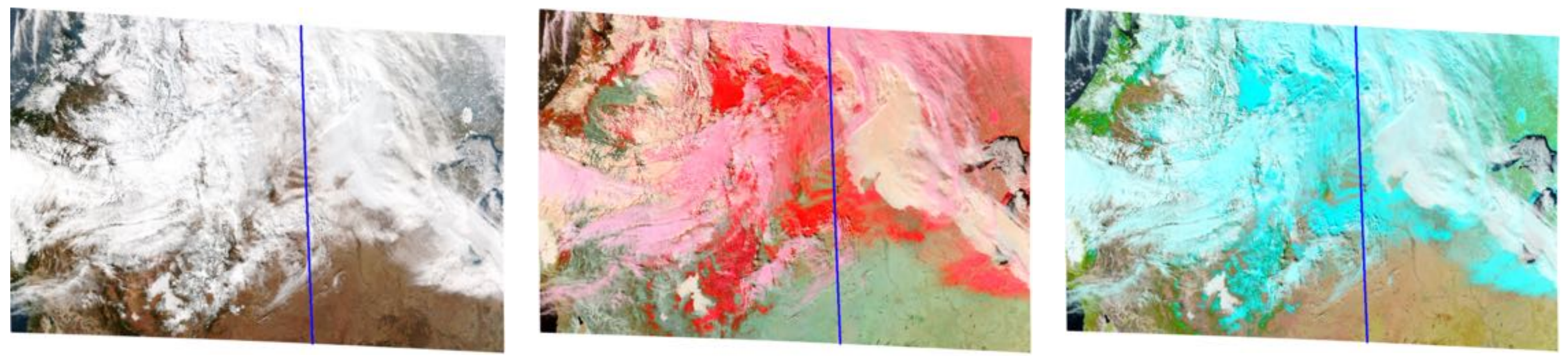
VIIRS IR window radiances plotted within collocated CrIS surface footprints. Note the elongation of CrIS footprints due to increased scan angle on the right half of the figure.

Cloud Validation

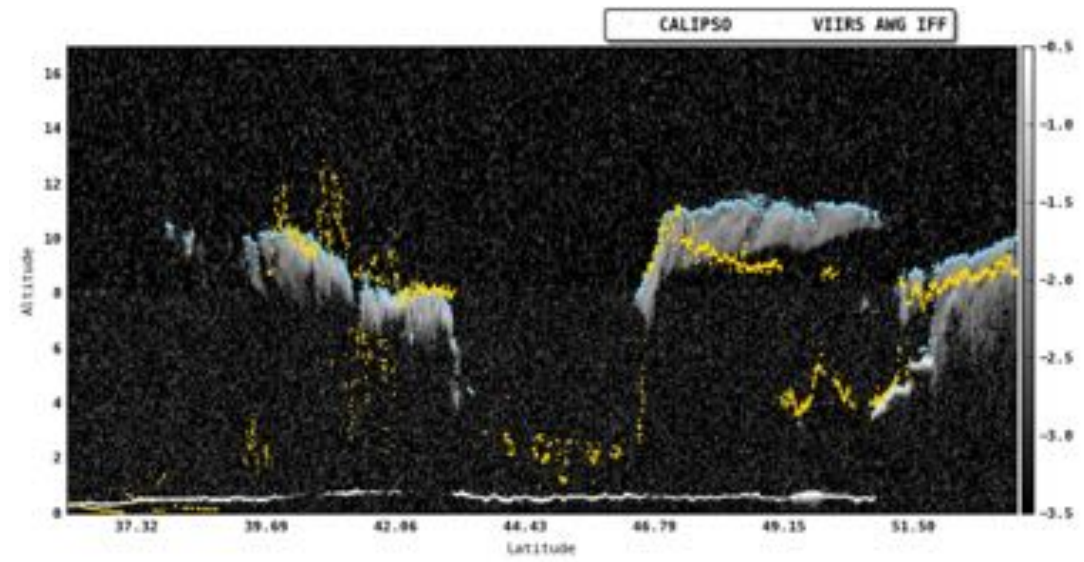
A major effort of the collocation project is the development of an integrated validation system which will provide AWG teams access to quantitative comparisons between GOES-R products and both active (CALIPSO, CloudSat) and passive (MODIS, VIIRS, CrIS, IASI) cloud, aerosol, and sounding observations. As part of this effort a centralized web interface is being developed to allow both viewing of imagery and access to "match files" that provide the collocated data products for analysis.



AWG cloud algorithms applied to VIIRS data for (shown left-to-right) retrieved cloud top altitude, effective radius, and cloud mask. Blue line indicates a collocated CALIPSO ground track.



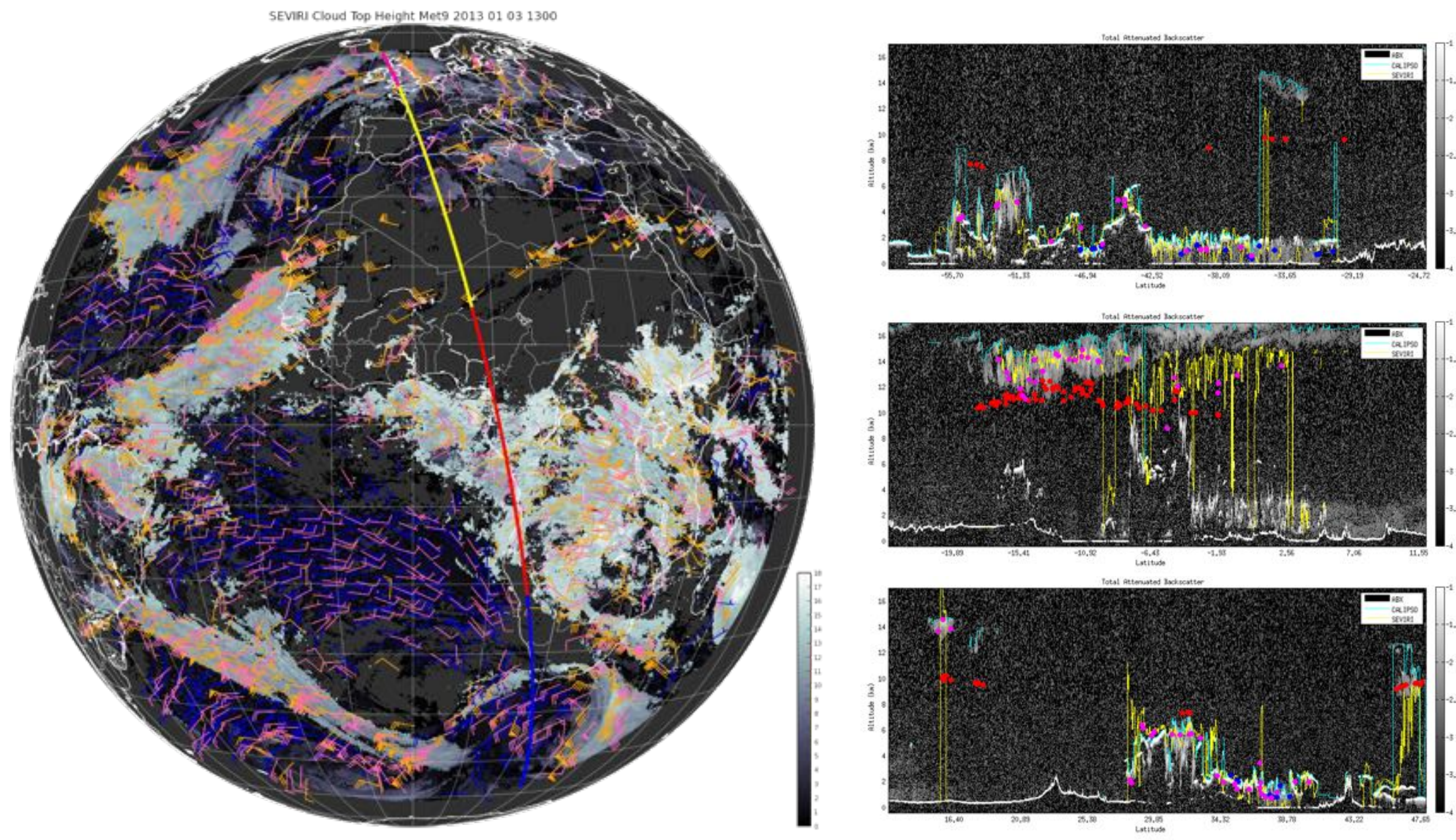
RGB quicklooks for same scene as above. From left to right: atmosphere-corrected true color, snow/ice composite (0.86/1.6/2.25μm), and natural color (1.6/0.86/0.67μm)



CALIOP attenuated backscatter with overlay of CALIOP level 2 cloud top height (cyan) and VIIRS AWG cloud top height (yellow). This profile corresponds to the blue track in the images above.

Wind Retrieved Height Validation

The collocation project has recently completed a processing run in collaboration with the AWG winds team, matching up 7 years of GOES wind retrievals with CALIPSO to validate the retrieval heights. Below are earlier results showing a SEVIRI-CALIPSO comparison. At left, SEVIRI AWG wind barbs are shown atop a greyscale cloud top height image, with a coincident CALIPSO ground track overlaid. At right, the CALIPSO backscatter profile is shown with retrieved wind heights (dots) and CALIPSO and SEVIRI cloud heights (cyan and yellow lines). From top to bottom the profile images correspond to the blue, red, and yellow track segments.



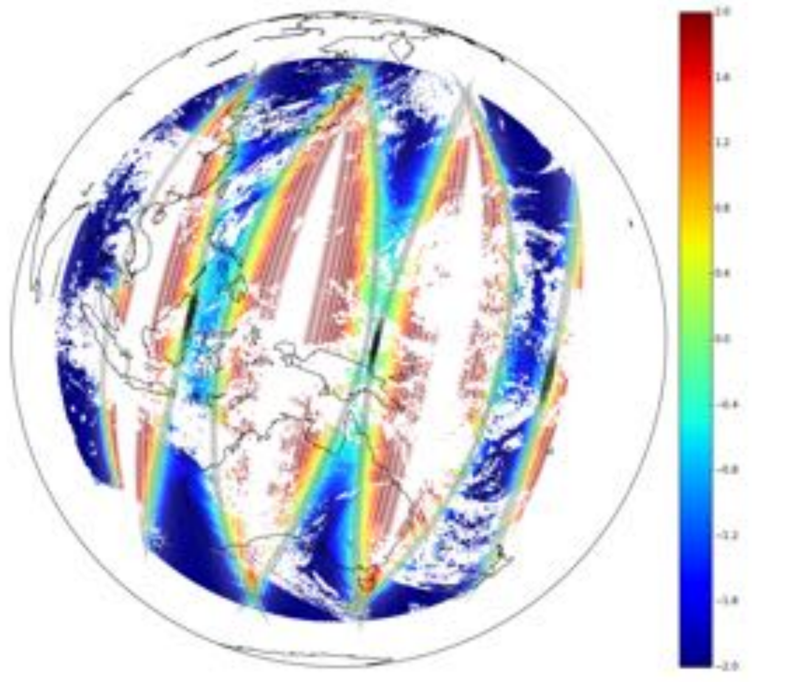
Moving Forward: AHI Then ABI

In the near future, the collocation project plans to use our level 2 validation framework to begin assessing AWG retrievals run on AHI data in preparation for ABI. Work is progressing both on local production of AHI derived products, and on ingesting products from the AIT's processing framework.

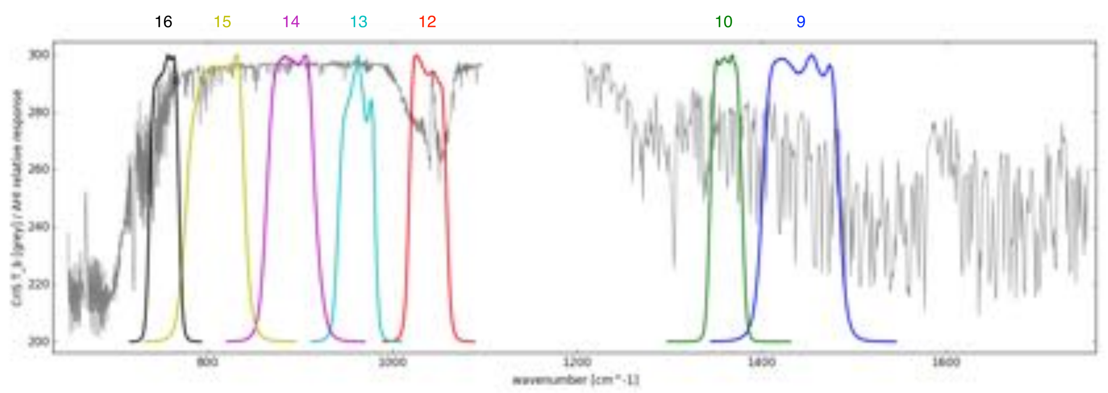
Assessing AHI IR Calibration Via CrIS

16 days (2015-Apr-06 through Apr-22) of Himawari-8 infrared radiance data has been compared to Suomi NPP CrIS for validation. This capability will be applied in near real time to GOES-R ABI upon launch, and will expand to include other validating sensors (IASI, VIIRS, …).

Himawari-8 AHI RGB image (0.64/0.51/0.47μm) with atmospheric correction calculated from AHI spectral response functions, for use in collocation quicklook imagery. [2015-Apr-15 01:30 UTC]



AHI Band 9 brightness temperature difference from CrIS (AHI minus CrIS, degrees K). Grey shadings indicate where AHI and CrIS observations have similar (+/- 4 degree) sensor zenith angles (relatively good comparisons). Black shadings indicate where both sensor zenith and azimuth angles are similar (best comparisons). This shows one day's worth of descending SNPP passes.



7 AHI bands are overlapped fully by the hyperspectral CrIS data. AHI bands 9 and 10 overlap the CrIS midwave band. AHI bands 12 through 16 overlap the CrIS longwave band.

Comparing AHI to CrIS involves aggregating AHI spatially to simulate CrIS resolution and aggregating CrIS spectrally to simulate the AHI band response functions. Distributions of differences are shown in blue for comparisons where sensor zenith angles are within 5 degrees and in green where both sensor zenith and azimuth angles are within 5 degrees. Scenes where AHI brightness temperature standard deviation exceeds 0.2K are not included.